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Belanger

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(54) **TILED VIEWPORT COMPOSITION**

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G06T 1/60	(2006.01)
G09G 5/14	(2006.01)
G09G 5/399	(2006.01)

(52) **U.S. Cl.**

CPC .. ***G06T 1/60*** (2013.01); ***G09G 5/39*** (2013.01); *G09G 5/14* (2013.01); *G09G 5/399* (2013.01); *G09G 2360/122* (2013.01); *G09G 2360/125* (2013.01)

(58) **Field of Classification Search**

CPC G09G 5/14; G09G 2360/122; G09G 5/39; G06T 1/60

See application file for complete search history.

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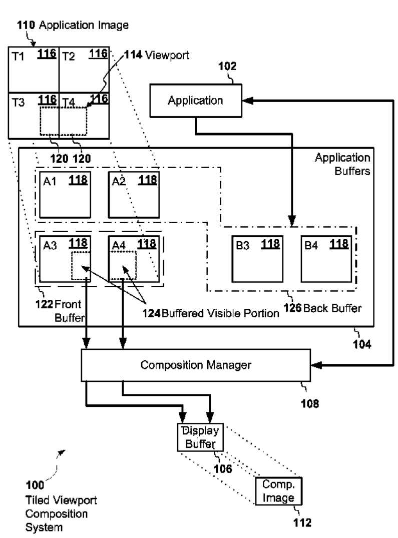
(57) **ABSTRACT**

A system that buffers an application image reduces bandwidth requirements for accessing memory. The application image may be logically separated into tiles. A viewport may identify a visible portion of the application image, where the visible portion is smaller than the application image. The tiles overlapped by the viewport may be buffered in a front buffer and a back buffer. The tiles not overlapped by the viewport may be buffered in the back buffer but not in the front buffer. A composition manager, with knowledge of the viewport and at least two noncontiguous tile buffers in the front buffer, may extract the visible portion of the application image directly from the noncontiguous tile buffers.

16 Claims, 3 Drawing Sheets



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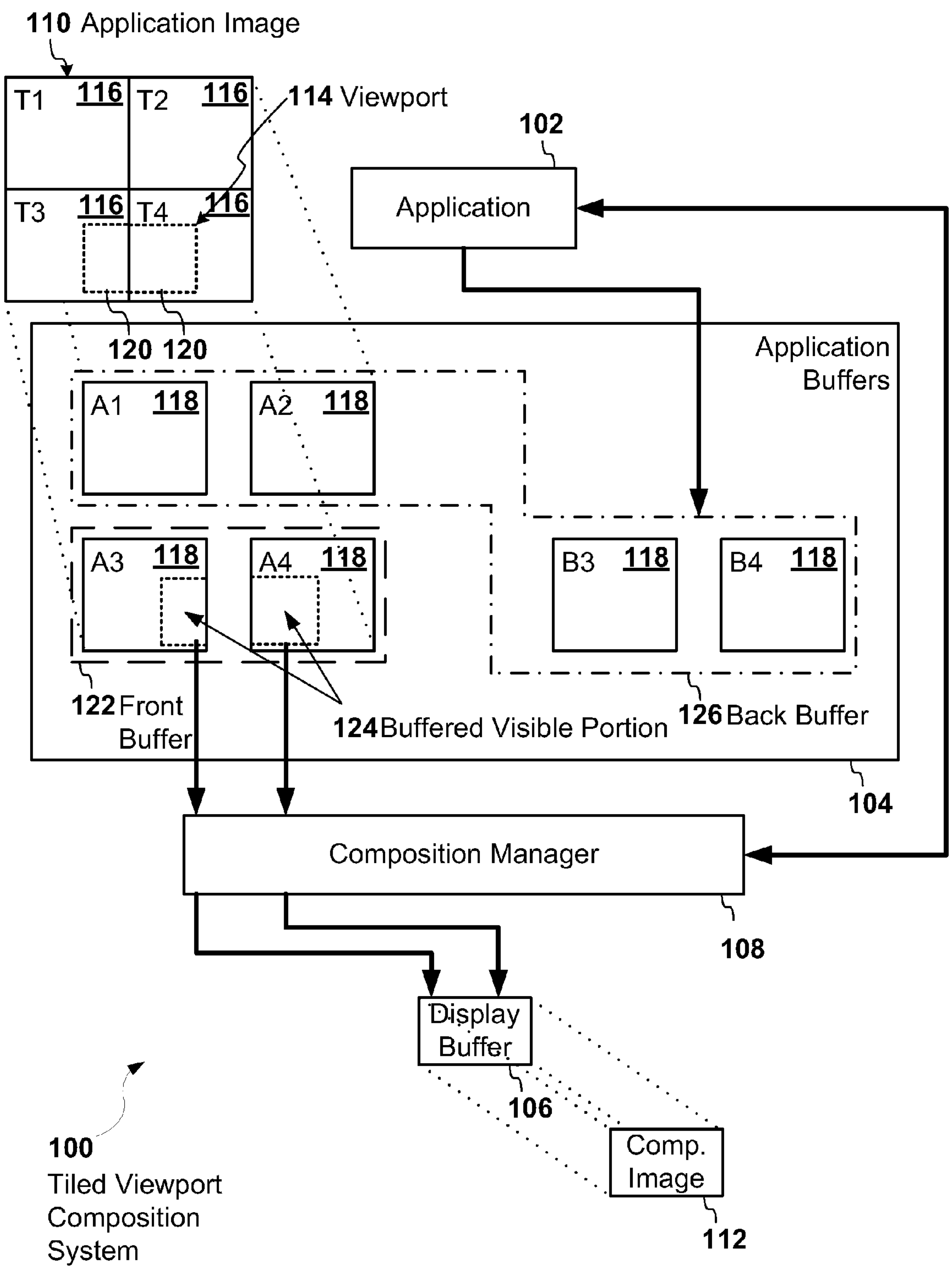
110 Application Image
T1 116
T2 116
T3 116
T4 116
114 Viewport
120 120
102
Application
Application Buffers
A1 118
A2 118
A3 118
A4 118
B3 118
B4 118
122 Front Buffer
124 Buffered Visible Portion
126 Back Buffer
104
Composition Manager
108
Display Buffer
106
Comp. Image
112
100
Tiled Viewport Composition System

FIG. 1

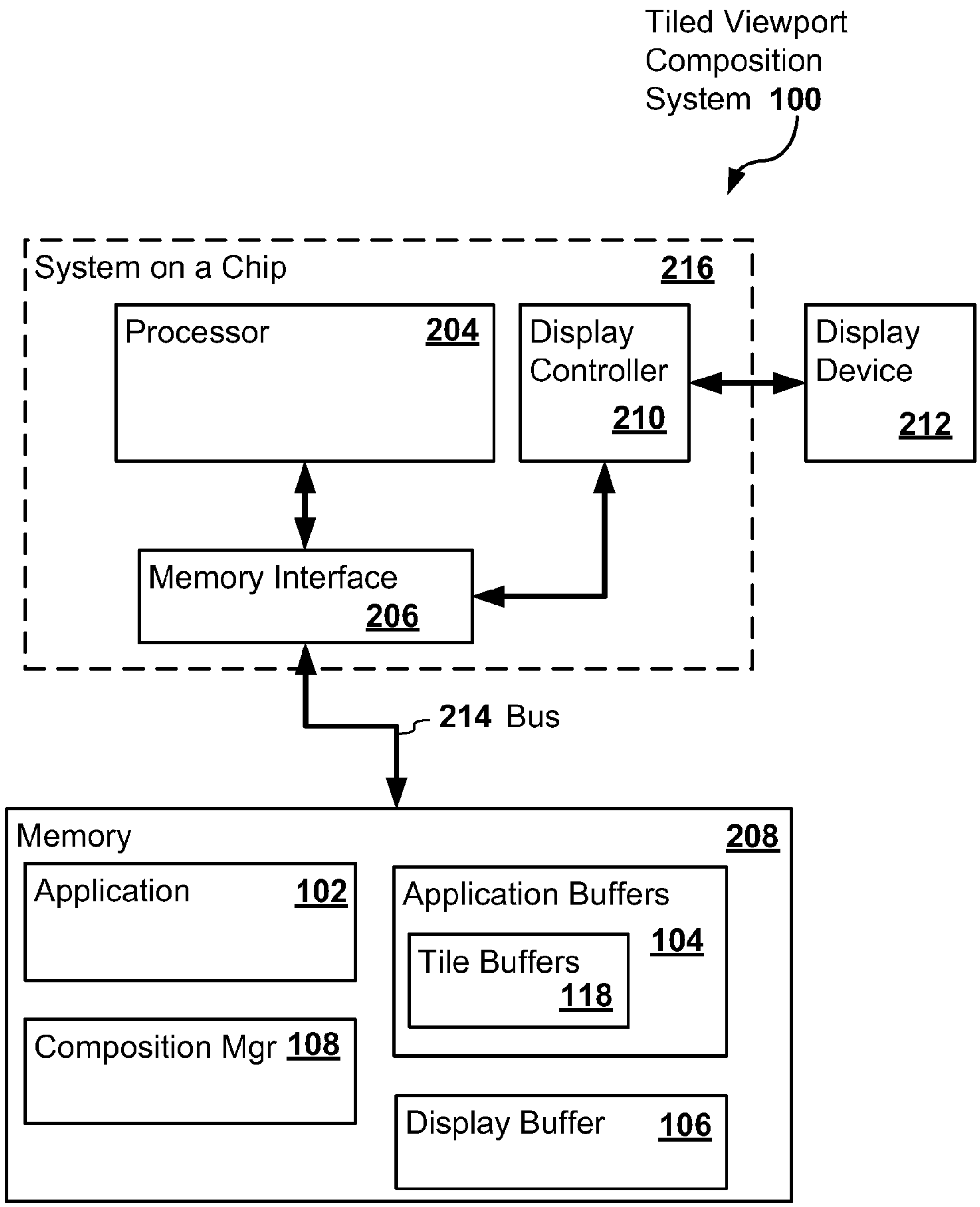
Tiled Viewport
Composition
System 100
System on a Chip 216
Processor 204
Display
Controller
210
Display
Device
212
Memory Interface
206
214 Bus
Memory 208
Application 102
Application Buffers
104
Tile Buffers
118
Composition Mgr 108
Display Buffer 106

FIG. 2

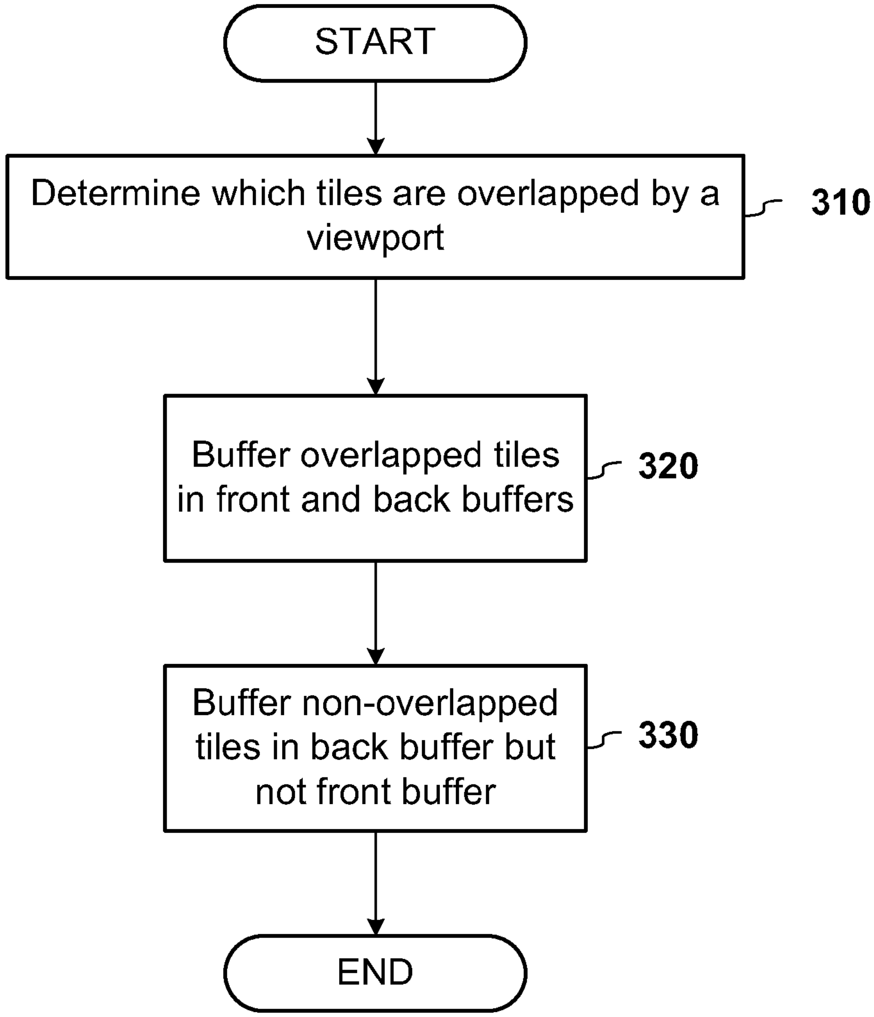
START
Determine which tiles are overlapped by a viewport
310
Buffer overlapped tiles in front and back buffers
320
Buffer non-overlapped tiles in back buffer but not front buffer
330
END

FIG. 3

TILED VIEWPORT COMPOSITION

BACKGROUND

1. Technical Field

This disclosure relates to graphics and, in particular, to graphics buffers.

2. Related Art

Graphical user interfaces (GUI), Picture in Picture (PiP), and other types of graphical images may be composited from multiple independently rendered images. For example, a GUI may contain a background image and one or more rendered graphic layers on top of the background image. The graphic layers may comprise applications, task bars, or other type of graphic elements. Each of the graphic layers may be rendered in an application buffer independently of the other graphic layers by individual software applications. The graphic layers may be composited together into a single composite image in a display buffer, which may be presented on a display device, transmitted over a network, or otherwise processed. The application buffer may represent an image that is larger than the corresponding graphic layer composited into the single composite image.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure may be better understood with reference to the following drawings and description. The components in the figures are not necessarily to scale. Moreover, in the figures, like-referenced numerals designate corresponding parts throughout the different views.

FIG. **1** is a tiled viewport composition system;

FIG. **2** is a hardware diagram of a tiled viewport composition system; and

FIG. **3** is a flow diagram of the logic of a tiled viewport composition system.

DETAILED DESCRIPTION

A system for buffering an application image may include a composition manager and a memory comprising a front buffer and a back buffer. The application image may be logically divided or separated into tiles. Each of the tiles may identify a corresponding area of the application image. The composition manager may determine which of the tiles are overlapped by a viewport. The viewport may identify a visible portion of the application image. The visible portion may be smaller than the application image. For example, the visible portion may be a portion of a map that is displayed on a display device in a navigation system.

In some systems, the composition manager (or an application that renders the application image) may double buffer (or more generally, multiple buffer) the tiles that the viewport overlaps. The composition manager (or the application) may not double buffer (or multiple buffer) the tiles that the viewport does not overlap. Reducing the amount of memory that is multiple buffered may reduce bandwidth requirements for accessing the memory.

Double buffering may prevent visual tearing artifacts caused when one process writes to a buffer while another process reads from the same buffer. To decrease or avoid the possibility of causing such visual defects, the application may render the application image in the back buffer while another process, such as the composition manager, reads the application image from the front buffer. More generally, a buffer that the system writes to in order to construct a frame of the application image may be the back buffer. A buffer that the system reads the completed frame from may be the front buffer. In examples in which multiple buffering is used, the system may include and use multiple back buffers.

In response to a vertical synchronization pulse or some other event, the front buffer and the back buffer may be switched such that the back buffer becomes the front buffer, and the front buffer becomes the back buffer. The buffer switch may also be referred to as a buffer flip. After the buffer flip, the back buffer may include the contents of frame n, and the front buffer may include the contents of frame n+1. If the entire contents of the front buffer (frame n+1) is copied to the back buffer (frame n), then the back buffer may have the most recent contents (frame n+1), and the application may begin rendering a new frame, n+2 in the back buffer. The process of rendering, flipping, and displaying may be repeated.

However, in the system for buffering the application image, copying the entire contents of the application image from the front buffer to the back buffer may be avoided when the buffer flip occurs. Instead, the composition manager and/or the application may skip double buffering (or multiple buffering) of the tiles that the viewport does not overlap. In particular, the composition manager and/or the application may buffer the tiles that are overlapped by the viewport in both the front and back buffers, and buffer the tiles that are not overlapped by the viewport in the back buffer but not in the front buffer.

Each of the tiles may be buffered in a corresponding tile buffer. The tile buffers may be noncontiguously arranged in memory. Two buffers may be noncontiguous if the buffers are not adjacent to each other in the memory address space of the memory that the buffers are in.

In some systems, the composition manager may copy a buffered visible portion of the application image directly from the noncontiguous tile buffers based on the composition manager having knowledge of the viewport and the tile buffers. The application does not need to create an intermediate buffer that contains the buffered visible portion of application image in contiguous memory so that the composition manager may copy the visible portion from the contiguous memory. Avoiding the creation of the intermediate buffer reduces the bandwidth requirements for accessing memory. The composition manager may generate a composite image from the visible portion of the application image and one or more additional application images.

FIG. **1** illustrates a tiled viewport composition system **100**. The system **100** may include an application **102**, application buffers **104**, a display buffer **106**, and a composition manager **108**. The tiled viewport composition system **100** is a system for buffering an application image **110**.

The application **102** may render the application image **110**. The application image **110** may include a window generated by a windows based operating system, such an operating system for a mobile electronic device, a desktop computer, or a server. Examples of the windows based operating system may include MICROSOFT WINDOWS®, which is a registered trademark of Microsoft Corporation of Redmond, Wash.; LINUX®, which is a registered trademark of Linus Torvalds of Finland; and ANDROID™, which is a trademark of Google, Inc. of Mountain View, Calif. Alternatively or in addition, the application image **110** may include a Graphical User Interface (GUI), a Picture in Picture (PiP), a task bar, a background picture, a frame in a sequence of frames that may be part of a video, or any other type of digital image. Examples of the application **102** may include a word processing program, a mail program, a web browser, a mobile application, or other types of software program or hardware component that may render the application image **110**.

The application buffers **104** may be one or more areas of memory that represent the application image **110** and/or portions thereof. The memory may include contiguous and/or noncontiguous areas of memory.

The display buffer **106** may comprise an area of memory that represents a composite image **112** assembled from individual images generated by one or more applications, such as the application **102** illustrated in FIG. **1**. The composite image **112** may be presented on a display device, transmitted over a network, or locally or remotely processed.

The composition manager **108** may composite or direct the composition of the individual images into the composite image **112**. The individual images may include all or a portion of application images. Examples of the composition manager **108** include a hardware compositor, a window manager, or any other component that composites individual images into the composite image **112**.

During operation of the tiled viewport composition system **100**, the composition manager **108** may render the composite image **112** from a visible portion of the application image **110** identified by a viewport **114**. The visible portion identified by the viewport **114** may be smaller than the entire application image **110**. The composition manager **108** may render the composite image **112** from the visible portion of the application image **110** and from one or more additional images.

The application **102** may move the viewport **114** around the application image **110** as the visible portion of the application image **110** changes over time. In one example, the application image **110** may be a map image, and the viewport **114** identifies the portion of the map image that is to be displayed in a navigation system. As the location of the navigation system changes, the portion of the map image displayed in the navigation system may also change. In a second example, the application image **110** may be an image of a level in a video game, and the viewport **114** may identify the portion of an image of the level that is to be displayed on a screen. As a game character moves around the level, the portion of the image of the level displayed on the screen changes. In a third example, a webpage viewer may render more content than may be shown on the display. The composite image **112** may update more quickly, or produce a visibly smoother transition appearance, when the application **102** uses the viewport **114** to update the visible portion of the application image **110**.

The application **102** may logically divide or partition the application image **110** into tiles **116**. Each of the tiles **116** may identify a corresponding area of the application image **110**. The tiles **116** may be uniform in size and shape throughout the application image **110**. Alternatively, the size and the shape of the tiles **116** may vary throughout the application image **110**. The size and shape of the tiles **116** may be different in different examples.

The tiles **116** may be represented in corresponding tile buffers **118**. For example, the tiles **116** that are individually designated T1-T4 in FIG. **1** may be represented in the tile buffers **118** that are individually designated A1-A4. The tile buffers **118** may be included in the application buffers **104**.

The composition manager **108** may determine which of the tiles **116** are overlapped by the viewport **114**. Each of the tiles **116** that are overlapped or intersected by the viewport **114** may contain at least part **120** of the visible portion of the application image **110**. In contrast, the tiles **116** that are not overlapped by the viewport **114** may not contain any visible part **120** of the application image **110**.

The composition manager **108** may double buffer the tiles **116** that are overlapped by the viewport **114**, but not the remaining tiles **116**. A front buffer **122** may include the tile buffers **118** (A3 and A4) representing the tiles **116**, (T3 and T4) overlapped by the viewport **114**. Accordingly, the tile buffers **118** (A3 and A4) in the front buffer **122** include a buffered visible portion **124** of the application image **110**. Conversely, a back buffer **126** may include the tile buffers **118** (A1 and A2) representing the tiles **116** (T1 and T2) not overlapped by the viewport **114**. In addition, the back buffer **126** may include the tile buffers **118** (B3 and B4) that correspond to the tile buffers **118** (A3 and A4) that are in the front buffer **122** and that represent the tiles **116** overlapped by the viewport **114**.

When generating the composite image **112**, the composition manager **108** may extract the buffered visible portion **124** of the application image **110** from the tile buffers **118** (A3 and A4) that are in the front buffer **122**. The buffered visible portion **124** may be of frame n of the application image **110**. The application **102** may render frame n+1 of the application image **110** in the back buffer **126** by modifying the tile buffers **118** (A1, A2, B3, and B4) that are in the back buffer **126**.

When a buffer flip occurs, the composition manager **108** may copy the contents of a subset of the tile buffers **118** that are in the back buffer **126** to the front buffer **122**. The subset of the tile buffers **118** may be the tile buffers **118** (B3 and B4) that correspond to the tile buffers **118** (A3 and A4) that are in the front buffer **122**. The composition manager **108** may skip copying tile buffers **118** (A1 and A2) representing the tiles **116** (T1 and T2) not overlapped by the viewport **114** to the front buffer **122**.

Alternatively or in addition to copying the contents of the subset of the tile buffers **118** from the back buffer **126** to the front buffer **122** when the buffer flip occurs, the composition manager **108** may change an association between the tile buffers **118** and the front and back buffers **122** and **126**. The composition manager **108** may track, in a data structure, which of the tile buffers **118** are associated with the front buffer **122**, and which of the tile buffers **118** are associated with the back buffer **126**. The associations between the tile buffers **118** and the front and back buffers **122** and **126** indicate which of the tile buffers **118** are included in each of the front and back buffers **122** and **126**. When the buffer flip occurs, the composition manager **108** may disassociate the subset of the tile buffers **118** (B3 and B4) from the back buffer **126**, and associate the subset of the tile buffers **118** (B3 and B4) with the front buffer **122**. Correspondingly, the composition manager **108** may change the tile buffers **118** (A3 and A4) that were originally associated with the front buffer **122** to be associated with the back buffer **126**. In other words, the composition manager **108**, in response to the buffer flip, may swap a first set of the tile buffers **118** associated with the front buffer **122** with a second set of the tile buffers **118** associated with the back buffer **126**, where the tile buffers **118** that are swapped represent the tiles **116** that the viewport **114** overlaps but not the tiles **116** that the viewport **114** does not overlap.

When the composition manager **108** swaps the tile buffers **118** that are associated with the front buffer **122** with the corresponding tile buffers **118** that are associated with the back buffer **126**, then the tile buffers **118** swapped into the back buffer **126** may represent an older frame, such as frame n. The tile buffers **118** swapped into the front buffer **126** may represent frame n+1. After the buffer swap, the application **102** may render a third frame, such as frame n+2, in the back buffer **126**.

When the viewport **114** moves and overlaps a new one of the tiles **116**, the composition manager **108** may double buffer the newly overlapped tile **116**. Conversely, when the viewport **114** moves and no longer overlaps one of the tiles **116**, then the composition manager **108** may stop double buffering the previously overlapped tile **116**.

Accordingly, when the viewport **114** moves, the composition manager **108** may adjust which of the tile buffers **118** are in the front buffer **122** so that the tile buffers **118** in the front buffer **122** correspond to the tiles **116** overlapped by the viewport **114**. Similarly, when the viewport **114** moves, the composition manager **108** may adjust which of the tile buffers **118** are in the back buffer **126**.

When the viewport **114** moves and overlaps a newly overlapped tile **116**, then the tile buffer **118** in the back buffer **126** that corresponds to the newly overlapped tile **116** may be included in the front buffer **122**. The tile buffer **118** added to the front buffer does not need to be completely re-rendered because the application **102** may have already rendered the tile buffer **118** in the back buffer **126**.

In some systems, the tile buffers **118** may be dynamically allocated and freed as the viewport **114** moves. For example, if the viewport **114** moves and overlaps four of the tiles **116** (T**1**-T**4**) illustrated in FIG. **1** instead of two of the tiles **116** (T**3** and T**4**), then the composition manager **108** may dynamically allocate two tile buffers **118** (B**1** and B**2**, which are not shown in FIG. **1**). The front buffer **122** may then include four of the tile buffers **118** (A**1**-A**4**), and the back buffer **126** may include the four corresponding tile buffers **118** (B**1**-B**4**).

As an alternative to dynamically allocating the tile buffers **118**, the tile buffers **118** may be allocated in advance. For example, upon an initialization requested by the application **102**, the composition manager **108** may allocate enough of the tile buffers **118** to fully represent the application image **110** in both the back buffer **126** and the front buffer **122**. The composition manager **108** may dynamically associate the pre-allocated tile buffers **118** to the front and back buffers **122** and **126**.

The application **102** and the composition manager **108** may have different features than those described. In one system, the composition manager **108** (instead of the application **102**) may divide or partition the application image **110** into tiles **116**. The application **102** may invoke an API (Application Programming Interface) to indicate to the composition manager **108** the size of the application image **110**. In response, the composition manager **108** may divide the application image **110** into the tiles **116** and allocate the corresponding tile buffers **118**. In another system, the application **102** (instead of the composition manager **108**) may double buffer the tiles **116** that are overlapped by the viewport **114**, but not the remaining tiles **116**. In still another system, one or more components other than the application **102** and the composition manager **108** may execute described functions of the application **102** and the composition manager **108**.

The composition manager **108** may render the composite image **112** from the visible portion of the application image **110** identified by the viewport **114**. The composition manager **108**, having knowledge of the tile buffers **118** and the viewport **114**, may copy the buffered visible portion **124** directly from the tile buffers **118** in the front buffer **122** to the display buffer **106** even if the buffered visible portion **124** is spread across multiple noncontiguous tile buffers **118**. Copying the buffered visible portion **124** from the tile buffers **118** in the front buffer to an intermediate buffer, and then copying from the intermediate buffer to the display buffer **106** may be unnecessary. The application **102**, for example, may provide the composition manager **108** with information about the viewport **114** and about the tile buffers **118** in the front buffer **122**. The composition manager **108** may use the information provided by the application **102** to copy the buffered visible portion **124** from the tile buffers **118** in the front buffer **122** to the display buffer **106**. Alternatively, the composition manager **108** may render the composite image **112** from an intermediate buffer. The intermediate buffer may be populated by the application **102** by copying from the buffered visible portion **124** in the front buffer **122**.

The frame of the application image **110** represented in the front buffer **122** may be frame n or any other frame. The frame of the application image **110** represented in the back buffer **126** may be frame n+1 or any other frame.

As described, the composition manager **108**, the application **102**, and/or some other component may double buffer the tiles **116** that are overlapped or lie or extend and cover part of by the viewport **114**. The composition manager **108** and/or the application **102** may apply multiple buffering to the tiles **116** that are overlapped by the viewport **114**, and not to the tiles **116** that are not overlapped by the viewport **114**. Multiple buffering may include double buffering, triple buffering, or other buffering processes and/or hardware that includes storing one or more frames of the application image **110** in one or more front buffers for extraction of the application image **110**, and storing one or more frames of the application image **110** in one or more back buffers for rendering of the application image **110**.

FIG. **2** is a hardware diagram of the tiled viewport composition system **100**. The tiled viewport composition system **100** may include a processor **204**, a memory interface **206**, and a memory **208**. The tiled viewport composition system **100** may be referred to simply as the system **100**.

The processor **204** may be hardware that executes computer executable instructions or computer code embodied in the memory **208** or in other memory to perform one or more features of the tiled viewport composition system **100**. The processor **204** may include a general processor, a central processing unit, a graphics processing unit, an application specific integrated circuit (ASIC), a digital signal processor, a field programmable gate array (FPGA), a digital circuit, an analog circuit, a microcontroller, any other type of processor, or any combination thereof.

The memory interface **206** may manage the transportation of data going to and from the memory **208**, such as between the processor **204** and the memory **208**. The memory interface **206** may include any memory controller, such as a Memory Chip Controller (MCC), a Double Data Rate2 (DDR2) memory controller used to drive DDR2 SDRAM (double data rate synchronous dynamic random-access memory), a Peripheral Component Interconnect (PCI) bus controller, or any other type of memory controller. The memory interface **206** may communicate with the memory **208** over a bus **214**, such as a 64 bit DDR2 bus operating at 400 Megahertz or any other type of bus.

The memory **208** may comprise a device for storing and retrieving data or any combination thereof. The memory **208** may include non-volatile and/or volatile memory, such as a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM), or a flash memory. Alternatively or in addition, the memory **208** may include an optical, magnetic (hard-drive) or any other form of data storage device.

The memory **208** may store computer code, such as the composition manager **108**, the application **102**, and/or any other application. The computer code may include instructions executable with the processor **204**. The computer code may be written in any computer language, such as C, C++, assembly language, shader code, channel program code, and/or any combination of computer languages.

The memory **208** may include buffers, such as the application buffers **104** and the display buffer **106**. The application buffers **104** may include the tile buffers **118**.

All of the disclosure, regardless of the particular implementation described, is exemplary in nature, rather than limiting. The system **100** may include more, fewer, or different components than illustrated in FIGS. **1** and **2**. For example, the system **100** may also include a display controller **210** and a display device **212**. The display controller **210** may read the composite image **112** from the display buffer **106** through the memory interface **206** and cause the composite image **112** to be displayed in the display device **212**.

The processor **204** may be in communication with the memory **208** via the memory interface **206**. The processor **204** may be in communication with other components, such as the display controller **210** and/or a network controller (not shown).

Furthermore, each one of the components of system **100** may include more, fewer, or different elements than is illustrated in FIGS. **1** and **2**. For example, the memory **208** may include more, fewer, or different modules, graphics buffers, and applications. Moreover, the application **102** and/or the composition manager **108** may include various modules. Flags, data, databases, tables, entities, and other data structures may be separately stored and managed, may be incorporated into a single memory or database, may be distributed, or may be logically and physically organized in many different ways. The components may operate independently or be part of a same program or hardware. The components may be resident on separate hardware, such as separate removable circuit boards, or share common hardware, such as a same memory and processor for implementing instructions from the memory. Programs may be parts of a single program, separate programs, or distributed across several memories and processors.

In some examples, one or more of the components of the system **100** may be included in a System on a Chip (SOC) **216**. For example, the SOC **216** may include the processor **204**, the memory interface **206** and the display controller **210**. In another example, the SOC **216** may include additional components, such as memory.

The system **100** may be implemented in many processes and/or systems. For example, although some features are shown stored in computer-readable memories as logic implemented as computer-executable instructions or as data structures in memory, portions of the system **100** and its logic and data structures may be stored on, distributed across, or read from any other machine-readable storage media. Examples of the storage media may include memories, a cache, a buffer, RAM, a removable media, a hard drive, a hard disk, a floppy disk, a CD-ROM, or any other type of machine-readable or computer-readable storage medium. The media may include any non-transitory computer-readable storage media, such as volatile or non-volatile memory, RAM, ROM, CD-ROM, any other suitable storage device or any combination thereof. Alternatively or in addition, features and/or modules described as logic implemented as computer-executable instructions or as data structures in memory may be implemented in hardware or in a combination of hardware and software, such as in a field programmable gate array (FPGA).

The functions, acts or tasks illustrated in the figures or described may be executed in response to one or more sets of logic or instructions stored in or on computer readable media. The functions, acts or tasks are independent of the particular type of instructions set, storage media, processor or processing strategy and may be performed by software, hardware, integrated circuits, firmware, micro code and the like, operating alone or in combination. Likewise, processing strategies may include multiprocessing, multitasking, parallel processing, distributed processing, and/or any other type of processing. In one embodiment, the instructions are stored on a removable media device for reading by local or remote systems. In other embodiments, the logic or instructions are stored in a remote location for transfer through a computer network or over telephone lines. In yet other embodiments, the logic or instructions may be stored within a given computer, central processing unit ("CPU"), graphics processing unit ("GPU"), or system.

The processing capability of the system **100** may be distributed among multiple entities, such as among multiple processors and memories, optionally including multiple distributed processing systems. Parameters and other data structures may be separately stored and managed, may be incorporated into a single memory or database, may be logically and physically organized in many different ways, and may be implemented with different types of data structures such as linked lists, hash tables, or implicit storage mechanisms. Logic, such as programs or circuitry, may be combined or split among multiple programs, distributed across several memories and processors.

FIG. **3** is a flow diagram of the logic of the tiled viewport composition system **100**. The application image **110** may be provided as logically divided into the tiles **116**. For example, the tile buffers **118** may be in the memory **208** and represent the tiles **116**.

The logic may determine (**310**) which of the tiles **116** are overlapped by the viewport **114**. The viewport **114** may identify the visible portion of the application image **110**, and the visible portion may be smaller than the application image **110**.

The tiles **116** that are overlapped by the viewport **114** may be buffered (**320**) in the front buffer **122** and the back buffer **126**, where the visible portion of the application image **110** is extracted from the front buffer **122**, and the application image **110** is modified in the back buffer **126**. For example, the front buffer **122** may buffer frame n, and the back buffer **126** may buffer frame n+1.

The tiles **116** not overlapped by the viewport **114** may be buffered (**330**) in the back buffer **126** in which the application image **119** is modified but not in the front buffer **122** from which the visible portion of the application image **110** is extracted. The logic may end, for example, by the composition manager **108** extracting the buffered visible portion **124** of the application image **110** from the front buffer **122**.

The logic may include additional, different, or fewer operations. In one such example, the logic may include dividing the application image **110** into the tiles **116** by allocating the tile buffers **118**. The operations may be executed in a different order than illustrated in FIG. **3**.

To clarify the use of and to hereby provide notice to the public, the phrases "at least one of <A>, <B>, . . . and <N>" or "at least one of <A>, <B>, . . . <N>, or combinations thereof" or "<A>, <B>, . . . and/or <N>" are defined by the Applicant in the broadest sense, superseding any other implied definitions herebefore or hereinafter unless expressly asserted by the Applicant to the contrary, to mean one or more elements selected from the group comprising A, B, . . . and N, that is to say, any combination of one or more of the elements A, B, . . . or N including any one element alone or in combination with one or more of the other elements which may also include, in combination, additional elements not listed.

While various embodiments have been described, it will be apparent to those of ordinary skill in the art that many more embodiments and implementations are possible within the scope of the disclosure. Accordingly, the disclosure is not to be restricted except in light of the attached claims and their equivalents.

What is claimed is:

1. A computer implemented method of buffering an application image comprising:

providing the application image separated into a plurality of tiles;

determining which of the tiles are overlapped by a viewport, wherein the viewport identifies a visible portion of the application image, and the visible portion is smaller than the application image;

buffering the tiles overlapped by the viewport in a front buffer and a back buffer, wherein the visible portion of the application image is extracted from the front buffer, the application image is modified in the back buffer, and the front buffer and the back buffer are in a computer-readable memory; and

buffering the tiles not overlapped by the viewport in the back buffer in which the application image is modified but not in the front buffer from which the visible portion of the application image is extracted even when the front buffer and the back buffer are flipped in a buffer flip.

2. The computer implemented method of claim 1, further comprising reading, with a composition manager having knowledge of the viewport and at least two noncontiguous tile buffers in the front buffer, a buffered visible portion of the application image directly from the at least two noncontiguous tile buffers.

3. The computer implemented method of claim 1 further comprising adjusting which of a plurality of tile buffers are in the front buffer when the viewport moves such that the tile buffers that are in the front buffer correspond to the tiles overlapped by the viewport but not to the tiles not overlapped by the viewport.

4. The computer implemented method of claim 1 further comprising copying, in response to the buffer flip, a first set of tile buffers in the back buffer to a second set of tile buffers in the front buffer, wherein the tile buffers that are copied represent the tiles overlapped by the viewport but not the tiles not overlapped by the viewport.

5. The computer implemented method of claim 1 further comprising swapping, in response to the buffer flip, a first set of tile buffers associated with the front buffer with a second set of tile buffers associated with the back buffer, wherein the tile buffers that are swapped represent the tiles overlapped by the viewport but not the tiles not overlapped by the viewport.

6. A system for buffering a first application image, the system comprising:

a processor; and

a memory comprising:

a front buffer;

a back buffer; and

a composition manager configured to determine which of a plurality of tiles intersect a viewport, wherein each of the tiles identifies a corresponding area of the first application image, the viewport identifies a visible portion of the first application image, and the visible portion is smaller than the first application image,

wherein the composition manager is further configured to buffer, in the front buffer and the back buffer, the tiles that intersect the viewport, wherein the composition manager extracts the visible portion of the first application image from the front buffer, and the first application image is rendered in the back buffer,

wherein the composition manager is further configured to buffer the tiles that are not intersected by the viewport in the back buffer in which the first application image is rendered but not in the front buffer from which the visible portion of the first application image is extracted even after the front buffer and the back buffer are flipped in a buffer flip, and

wherein the composition manager is further configured to generate a composite image from the visible portion of the first application image and a second application image.

7. The system of claim 6, wherein the composition manager is further configured to determine that at least two noncontiguous tile buffers in the front buffer intersect the viewport, and the composition manager is further configured to extract the visible portion of the first application image directly from the at least two noncontiguous tile buffers.

8. The system of claim 6 wherein the composition manager is further configured to divide the application image into the tiles in response to a request by an application.

9. The system of claim 6 wherein all of a plurality of tile buffers copied from the back buffer to the front buffer in response to the buffer flip represent only the tiles that intersect the viewport.

10. The system of claim 6 wherein all of a plurality of tile buffers swapped between the front buffer and the back buffer in response to the buffer flip represent only the tiles that intersect the viewport.

11. A non-transitory computer-readable storage medium encoded with computer executable instructions, the computer executable instructions executable with a processor to buffer an application image, the computer-readable storage medium comprising:

instructions executable to separate the application image into a plurality of tiles;

instructions executable to determine which of the tiles are overlapped by a viewport, wherein the viewport identifies a visible portion of the application image, and the visible portion is smaller than the application image;

instructions executable to buffer the tiles overlapped by the viewport in a front buffer and a back buffer, wherein the visible portion of the application image is extracted from the front buffer, the application image is modified in the back buffer; and instructions executable to buffer the tiles not overlapped by the viewport in the back buffer in which the application image is modified but not in the front buffer from which the visible portion of the application image is extracted even after the front buffer is switched with the back buffer in a buffer flip.

12. The computer-readable storage medium of claim 11, wherein tiles overlapped by the viewport are double buffered with the front buffer and the back buffer, and the tiles not overlapped by the viewport are not double buffered.

13. The computer-readable storage medium of claim 11, wherein the tiles overlapped by the viewport are multiple buffered with the front buffer and a plurality back buffers that include the back buffer, and wherein the tiles not overlapped by the viewport are not multiple buffered.

14. The computer-readable storage medium of claim 11 further comprising instructions executable to associate a tile buffer that is in the back buffer with the front buffer in response to a movement of the viewport, wherein the tile buffer represents a tile overlapped by the viewport after the movement of the viewport but not before the movement of the viewport.

15. The computer-readable storage medium of claim 14 further comprising instructions executable to copy the contents of the tile buffer between the front buffer and the back buffer in response to the movement of the viewport.

16. A system for buffering a first application image, the system comprising:

a processor; and

a memory comprising:

a front buffer;

a back buffer;

a composition manager; and

an application configured to determine which of a plurality of tiles intersect a viewport, wherein each of the tiles identifies a corresponding area of the first application image, the viewport identifies a visible portion of the first application image, and the visible portion is smaller than the first application image,

wherein the application is further configured to buffer, in the front buffer and the back buffer, the tiles that intersect the viewport, wherein the composition manager extracts the visible portion of the first application image from the front buffer, and the application renders the first application image in the back buffer,

wherein the application is further configured to buffer the tiles that are not intersected by the viewport in the back buffer in which the first application image is rendered but not in the front buffer from which the visible portion of the first application image is extracted regardless of whether the back buffer and the front buffer are flipped in a buffer flip, and

wherein the composition manager is configured to generate a composite image from the visible portion of the first application image and a second application image.

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